

Echocardiographic Assessment of Posterior Wall Thickness in Cardiac Patients: A Retrospective Study from Sudan

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Abstract: ***Aim of the study:** This study retrospectively assessed posterior wall thickness (PWT) using echocardiography. **Method:** A total of 113 patients' records with various cardiac conditions in Khartoum, Sudan, were reviewed between October 2022 and February 2023. Echocardiographic measurements, including left ventricular size, interventricular septum (IVS) thickness, ejection fraction (EF), and valve velocities, were analyzed along with patient demographics. **Results:** The findings showed a strong correlation between PWT and IVS thickness ($p < 0.001$) and a mild association with EF ($p = 0.006$), while no significant correlation was found with age, body mass index (BMI), or left ventricle size. **Conclusion:** Notably, obesity was associated with higher rates of abnormal PWT. These results underscore the significance of PWT in elucidating cardiac remodeling patterns and guiding localized cardiovascular interventions.*

Keywords: Echocardiography, Posterior Wall Thickness, Left Ventricular Hypertrophy, Cardiac Remodeling, Sudan.

1. Introduction

Cardiovascular diseases (CVDs) continue to be the leading cause of morbidity and mortality worldwide, resulting in approximately 17.9 million deaths annually, and pose a major public health challenge.^{1,2} This burden is in low- and middle-income countries, including those in Africa, where an epidemiological shift is driving an increase in chronic non-communicable diseases.³ In Sudan, for example, heart diseases are a leading cause of illness and death, with hypertensive heart disease, rheumatic heart disease, ischemic heart disease, and cardiomyopathy accounting for over 80% of reported CVD cases.^{4,5} Echocardiography is a cornerstone in the non-invasive assessment of cardiac structure and function, providing essential information on chamber sizes, wall thicknesses, valvular integrity, and myocardial performance.^{6,7} It plays a vital role in diagnosing various heart conditions, evaluating disease progression, and guiding treatment strategies. Key echocardiographic parameters, such as left ventricular (LV) dimensions, interventricular septum (IVS) thickness, posterior wall thickness (PWT), and ejection fraction (EF), are routinely measured to characterize myocardial remodeling and overall cardiac health.⁸ Left ventricular hypertrophy (LVH), characterized by an increase in myocardial mass often involving thickening of the IVS and PWT, is a common compensatory response to chronic pressure or volume overload (e.g., in hypertension or valvular heart disease) or other pathological conditions.^{9,10} LVH is a strong independent predictor of adverse cardiovascular events, including heart failure, arrhythmias, and sudden cardiac death.¹¹ The relationship between myocardial wall thickness, IVS, and LV systolic function (ejection fraction) is complex, reflecting various adaptive or maladaptive remodeling patterns.^{7,8} Although significant research exists on these parameters globally, localized data from specific populations, particularly in Africa, are essential to understand unique presentation patterns and correlations influenced by regional disease prevalence, genetics, and environmental factors. Hypertension and diabetes mellitus (DM), both non-communicable diseases (NCDs), are global public health

concerns.¹² Body mass index (BMI) was calculated from the patient's weight and height and categorized according to the World Health Organization (WHO) classification as either underweight.¹³ Understanding the distribution of PWT and its associations with cardiac parameters in the Sudanese population is crucial for tailoring diagnostic and treatment protocols in resource-limited settings, where cardiovascular disease profiles and risk factors may differ from global trends. This study aimed to assess the distribution and clinical relevance of posterior wall thickness (PWT) measurements via echocardiography among Sudanese patients with cardiac conditions.

2. Materials and Methods

2.1 Study design and population

This was a retrospective, cross-sectional study conducted among 113 patients with various cardiac conditions who were referred to Khartoum, Sudan, between October 2022 and February 2023. The study included medical records of individuals presenting with diverse cardiac etiologies, such as hypertension, D.M., coronary artery disease, and congenital heart disease.

Inclusion criteria: Complete medical records of patients aged 18 years and above.

Exclusion criteria: Incomplete patient records.

2.2 Echocardiographic evaluation

Comprehensive two-dimensional transthoracic echocardiography was performed on all participants using standard protocols. The following key echocardiographic parameters were measured:

- Left Ventricle (LV) size: End-diastolic dimension.
- Interventricular Septum (IVS) thickness: Measured at end-diastole.

- Posterior Wall Thickness (PWT): Measured at end-diastole.
- Ejection Fraction (EF): Assessed using standard methods (e.g., modified Simpson's method or visual estimation from 2D images).
- Valves velocities: Mitral, Tricuspid, Pulmonary, and Aortic valve velocities were recorded.
- Pericardial status: Presence or absence of pericardial effusion.

2.3 Techniques

All measurements were taken by experienced sonographers following established international guidelines to ensure consistency and accuracy. Each parameter was then classified as "Normal," "Mild Abnormal," "Moderate Abnormal," or "Severe Abnormal" based on these international reference values, using a high-resolution ultrasound machine with Doppler capabilities and the appropriate transducer (TOSHIBA with Phased array probe, convex face with a small footprint for "peeking" between rib interspaces at 2.5 MHz).

2.4 Data Collection and Analysis

Demographic data, including age, sex, and Body Mass Index (BMI), were collected from each participant's records.

All statistical analyses were performed using statistical software (SPSS). Descriptive statistics were used to summarize the baseline characteristics of the study population.

Associations for risk factors were calculated using Chi-square tests. A p-value < 0.05 indicated significance.

3. Results

Analysis of the 113 patients' records revealed an average age of 50 years. Males significantly outnumbered females (66.4% vs. 33.6%). The average BMI of 28.20 ± 6.08 kg/m² indicates a high prevalence of overweight status among participants. Geographic distribution showed a metropolitan concentration (51.3%), with urban (29.2%) and rural (19.5%) populations. Regarding cardiac causes, non-communicable diseases such as hypertension (15.9%), diabetes mellitus (15.0%), and obesity (14.2%) were prevalent. Other notable risk factors included family history of cardiac conditions (11.5%) and smoking (9.7%), as shown in Table 1.

Table 1: Distribution of age, sex, residence, and etiology among the study sample.

Age	Frequency	%
20-39 y	16	14.16%
40-59 y	36	31.86%
60-79 y	51	45.13%
80 y and above	10	8.85%
Total	113	100
Sex	No	%
Male	75	66.40%
Female	38	33.60%
Total	113	100
Residence	No	%
Metropolitan	58	51.30%

Nonmetropolitan urban	33	29.20%
Rural area	22	19.50%
Total	113	100
Etiology	No	%
Hypertension	18	15.90%
D.M	17	15.00%
Obesity	16	14.20%
Unknown	13	11.50%
Family History	13	11.50%
Smoking	11	9.70%
Coronary Artery Disease	7	6.20%
Cardiovascular Disease	5	4.40%
D.M & hypertension	2	1.80%
Abdominal aortic aneurysm	2	1.80%
Others	9	8%
Total	113	100

Pericardial assessment showed that most (69.9%) were normal, while a notable minority had either pericardial effusion (20.4%) or acute pericarditis (9.7%). Additionally, males are more prone to posterior wall thickening than females, as shown in Fig. 1.

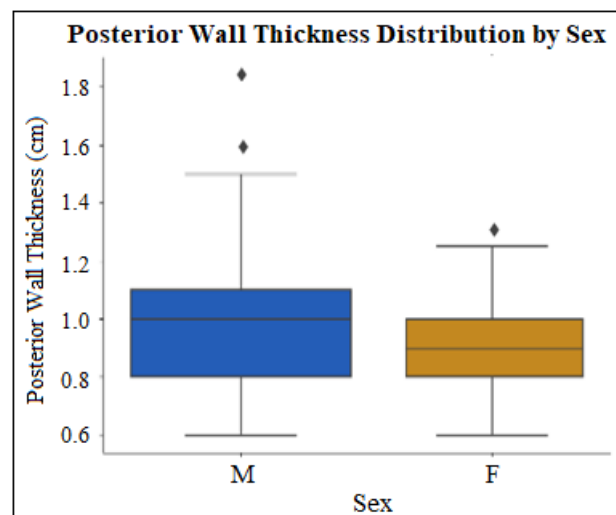


Figure 1: Distribution of sex among patients with posterior wall thickness.

Table 2: Demonstrates the study variables and the correlations with posterior wall thickening.

Variables	P-value
Age	0.191
BMI	0.863
Left Ventricle size	0.32
IVS thickness	0
Ejection Fraction	0.006

Table 3. Shows the distribution of PWT categories in relation to the sociodemographic data of the study sample.

Sex	Normal	Mild Abnormal	Moderate Abnormal	Severe Abnormal
M	62.20%	35.10%	2.70%	0
F	71.60%	21.60%	5.40%	1.40%
Residence	Normal	Mild Abnormal	Moderate Abnormal	Severe Abnormal
Metropolitan	63.80%	27.60%	6.90%	1.70%
Nonmetropolitan Urban	72.70%	24.10%	3.00%	0
Rural Area	75.00%	25.00%	0	0

Table 4: Top Etiologies vs. PWT Category among the study sample.

Etiology	Normal	Mild Abnormal	Moderate Abnormal	Severe Abnormal
D.M	70.60%	17.60%	11.80%	0
Family History	69.20%	23.10%	7.70%	0
Hypertension	70.60%	23.50%	5.90%	0
Obesity	62.50%	31.20%	0	6.20%
Unknown	75.00%	25.00%	0	0

4. Discussion

This study found a strong positive correlation ($p < 0.001$) between posterior PWT and IVS thickness, indicating proportional thickening of both structures. A mild, yet statistically significant, positive correlation ($p = 0.006$) was also observed between PWT and EF, suggesting a modest link where increased PWT may be associated with slightly better EF, as shown in Table 2.

Males showed a higher percentage of "Mild Abnormal" PWT (35.1%) compared to females (21.6%), while females had a higher proportion in the "Normal" category compared to males (71.6% vs. 62.2%), as shown in Table 3.

Analysis of PWT categories by geographic location revealed that people from rural and most non-metropolitan urban areas have a "Normal" PWT. This pattern is less clear among residents of metropolitan areas, as shown in Table 3.

Furthermore, patients with obesity had the highest percentage within the "Mild Abnormal" PWT category (31.2%), which is a significant finding, as shown in Table 4.

Over 30% of patients showed some level of abnormal PWT, highlighting the significant burden of cardiac structural and functional abnormalities in this study population, which is consistent with previous global and regional studies on cardiovascular diseases.^{13,14} The combination of hypertension and D.M is linked to a fourfold increase in mortality, as noted in a prior study.¹⁵ Macrovascular problems may include coronary artery disease, myocardial infarction, stroke, congestive heart failure, and peripheral vascular disease.¹⁶

This study demonstrated a strong and highly statistically significant positive correlation between PWT and IVS thickness ($p < 0.001$). This robust relationship indicates a coordinated increase in the thickness of both the posterior wall and the interventricular septum, a hallmark feature of concentric LVH in male patients rather than females, as shown in Fig. 1. A previous study found that the prevalence of LVH in the population ranges from 36% to 41%, depending on the parameters used to define it. There is no known difference in the prevalence of left ventricular hypertrophy between males and females.¹⁷ This pattern typically occurs as an adaptive response to chronic pressure overload, often seen in conditions such as systemic hypertension, which was common in our study group. Another study stated that the concurrent thickening of these walls helps maintain systolic function despite increased afterload, or excessive hypertrophy can eventually lead to diastolic dysfunction and heart failure.¹⁸

The study results also emphasize the importance of evaluating both PWT and IVS thickness together when assessing for LVH. Additionally, our study found a mild but statistically significant positive correlation between PWT and EF ($p = 0.006$). This relationship suggests that, within the studied range, a higher PWT may be linked to a slightly higher or preserved ejection fraction. Patients with LVH caused by persistent volume overload (mitral regurgitation) or pressure overload (aortic stenosis) may undergo years of a compensatory phase during which they exhibit no symptoms and maintain a normal or nearly normal exercise reserve. For others, diastolic dysfunction, systolic dysfunction, or both may drive the progression to heart failure.¹⁹ Another study showed that LVH is associated with age and obesity in various populations.⁹

The observation that males had a higher percentage of "Mild Abnormal" PWT compared to females, while females had a higher ratio in the "Normal" category, aligns with some research suggesting that clinical trials showed that women have lower LV volume, lower LV mass, and increased LV ejection fraction than men. However, other studies showed that male hearts exhibit a greater expansion of extracellular volume than female hearts, suggesting a link between higher fibrosis levels and chronic volume overload.^{20,21,22,23,24} The higher prevalence of abnormal PWT categories among patients with obesity also warrants attention, reinforcing the established connection between obesity and cardiac remodeling. Although the direct linear correlation with BMI was weak in our cohort, these categorical associations, while not statistically tested, lay a foundation for future research.

5. Conclusion

This study demonstrated a significant association between posterior wall thickness (PWT) and interventricular septum (IVS) thickness, reflecting concentric left ventricular hypertrophy patterns in the studied population. The correlation with ejection fraction suggests nuanced compensatory adaptations. These insights have direct relevance for clinical cardiology practices in Sudan and underscore the importance of localized echocardiographic assessments. Future research should further explore causative mechanisms and potential interventions.

Competing Interest

The author states that there are no competing interests.

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